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PATENT SPECIFICATION

NO DRAWINGS

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Inventor: JAMES WILLIAM GREEN

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COMPLETE SPECIFICATION

Process for producing Beers of Low Carbohydrate Content

We, A.B.M. INDUSTRIAL PRODUCTS LIMITED, a British Company of Bristol Road, Gloucester, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for producing beers of low residual carbohydrate content, such beers being especially suitable for diabetic persons or others for whom a low carbohydrate diet is essential or desirable.

The process makes use of the enzyme amyloglucosidase (glucamylase) to hydrolyse the unfermented carbohydrate normally remaining in beer. It is known that some 20—25% of the total carbohydrate of wort is unfermentable by yeast and persists in the finished beer. The major part of this unfermented carbohydrate consists of glucose oligosaccharides including the so-called "dextrins" of wort. It has been found that by the action of amyloglucosidase enzyme this unfermented carbohydrate can be converted to the readily fermentable sugar glucose.

Thus we have found that beer with a predetermined low residual carbohydrate content can advantageously be produced by adding to the yeast-fermenting beer wort a quantity of the enzyme amyloglucosidase, allowing a fermentation to proceed until only the predetermined amount of residual carbohydrate remains in the beer and then inactivating the enzyme by heat treatment.

According to the present invention, therefore, there is provided a process for the production of beer with a predetermined low residual carbohydrate content which comprises adding to the yeast-fermenting beer wort a quantity of the enzyme amyloglucosidase, allowing fermentation to proceed until only the predetermined amount of residual carbohydrate remains in

the beer and then inactivating the enzyme by heat treatment.

The invention also provides beer when produced by such a process.

The predetermined residual carbohydrate content is, for example, not more than 1% by weight.

The enzyme is preferably inactivated by heating to about 180°F. and maintaining this temperature for about 15 seconds. However the enzyme can also be inactivated by heating to a higher temperature for a shorter period or by heating to a lower temperature for a longer period. However it is to be appreciated that the higher the temperature or the longer the time at which the elevated temperature is maintained the greater the likelihood of producing undesirable taste changes in the beer.

It is to be noted that heating the beer to inactivate the enzyme also pasteurises the beer.

The preferred method of heat treating the beer is by passing it through a plate type heat exchanger.

It is preferred to add the enzyme to the fermenting beer wort immediately after the bulk of the fermentation yeast has been separated from the fermenting beer wort, i.e. after "skimming" in the case of top fermentation beers and after transfer to lagering tanks in the case of bottom fermentation beers. This is because the enzyme tends to be absorbed on to the yeast and is subsequently largely removed with the yeast before it has had time to act on the unfermentable residual carbohydrates. Thus if the enzyme is added before yeast separation it is then necessary to add considerably more of it.

The preferred form of the enzyme is an amyloglucosidase produced by a species of the mould *Aspergillus*. This enzyme catalyses the hydrolytic fission of α , 1—4 and α , 1—6 bonds of glucose oligosaccharides. The action

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- of the enzyme is to split off successive glucose molecules from the non-reducing ends of such glucose chains. The enzyme has a pH of optimum activity close to 5.0 and thus is active at the pH values of wort and of beer. The temperature of optimum activity is close to 130°F but the enzyme is active at the lower temperatures normally employed in brewing.
- It is an essential feature of the process of the present invention that the enzyme is inactivated because the yeast must be removed almost completely from the stored beer before it is bottled or despatched in cask. If the enzyme has not been inactivated it continues the breakdown of any residual carbohydrate to glucose which would not be fermented while there is no yeast present, and would remain in the beer. Clearly this is an undesirable substance in a beer for diabetics. Since it would be required to store the beer for a long time before filtering or fining to achieve substantially no residual carbohydrates it is necessary to choose an acceptable predetermined amount of residual carbohydrate which has been found

by experiment can be achieved in a desirable storage time and then inactivate the enzyme when this amount only remains in the beer.

The following Examples will serve to illustrate the invention.

EXAMPLE 1

A beer of the pale ale type was collected at the end of primary fermentation (after skimming) and divided into two portions. The first portion was conditioned, filtered, bottled and pasteurised in the normal way as a control. The other portion was treated with the amyloglucosidase (produced by A.B.M. Industrial Products Limited) "Amylozyme MS", at the rate of 4 oz. per barrel. The enzyme was allowed to act during the 5 days conditioning period, after which the beer was filtered, the enzyme inactivated by passing the beer through a plate heat exchanger to raise the temperature to 180°F for an average dwell time of 15 seconds and the beer bottled.

Analysis of the two beers gave the following results:

	Untreated Beer	Enzyme treated Beer
Residual Gravity	1005.9	1001.0
Total residual Carbohydrate	2.1% by weight	0.96% by weight
% Dextrose Equivalent	0.25	0.08

Qualitative differences in the carbohydrate spectrum of the two beers were shown by

paper chromatography and are represented in the following table:

	Untreated Beer	Enzyme treated Beer
Dextrins	--	--
Maltotetraose	--	--
Maltotriose	--	--
Maltose	--	--
Sucrose	--	--
Glucose	--	--
Fructose	--	--

The results show that enzyme treatment has greatly reduced the total carbohydrate content of the beer and almost completely removed free sugars.

EXAMPLE 2

The importance of inactivating the enzyme is shown in the following example:

- 5 A lager beer was treated after transfer to lagering tanks with the enzyme "Amylozyme MS" at the rate of 2 oz. per barrel. After conditioning, the beer was filtered and divided

into two portions. The first portion was bottled and given normal in-bottle pasteurisation. The other portion was heated to 180°F for 15 seconds to inactivate the enzyme and bottled.

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Samples were analysed at intervals during storage with the following results:

- A = samples given normal pasteurisation
 B = samples given 15 seconds at 180°F to inactivate the enzyme.

		Residual Gravity	% Dextrose Equivalent by weight	Glucose by Chromatography
Initial samples	A	1001.2	0.10	trace
	B	1001.2	0.10	trace
2 weeks	A	1001.2	0.30	+
4 weeks	A	1001.4	0.56	+
6 weeks	A	1001.4	0.75	++
8 weeks	A	1001.5	0.80	++
10 weeks	A	1001.5	0.80	++
	B	1001.2	0.10	trace

- 15 The results show that while the beer in which the enzyme was inactivated is unchanged during storage, further enzyme action has continued in the normally pasteurised beer for up to about seven weeks resulting in a significant increase in the concentration of glucose.

WHAT WE CLAIM IS:—

1. A process for the production of beer with a predetermined low residual carbohydrate content which comprises adding to the yeast-fermenting beer wort a quantity of the enzyme amyloglucosidase, allowing fermentation to proceed until only the predetermined amount of residual carbohydrate remains in the beer 25 and then inactivating the enzyme by heat treatment.
2. A process according to claim 1 wherein the enzyme is inactivated by heating to about 180°F and maintaining this temperature for about 15 seconds.
3. A process according to claim 1 or claim 2, wherein the enzyme is added to the ferment-

ing beer wort immediately after the bulk of the fermentation yeast has been separated from the wort.

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4. A process according to any one of the preceding claims wherein the enzyme is an amyloglucosidase produced by a species of the mould *Aspergillus*.

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5. A process according to any one of the preceding claims wherein the predetermined residual carbohydrate content is not more than 1½% by weight.

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6. A process for the production of beer with a predetermined low residual carbohydrate content substantially as hereinbefore described with reference to Example 1 or Example 2.

7. Beer when produced by a process according to claim 1.

For the Applicants,
GRAHAM WATT & CO.,
 Chartered Patent Agents,
 3/4 South Square, Grays Inn,
 London, W.C.1.

